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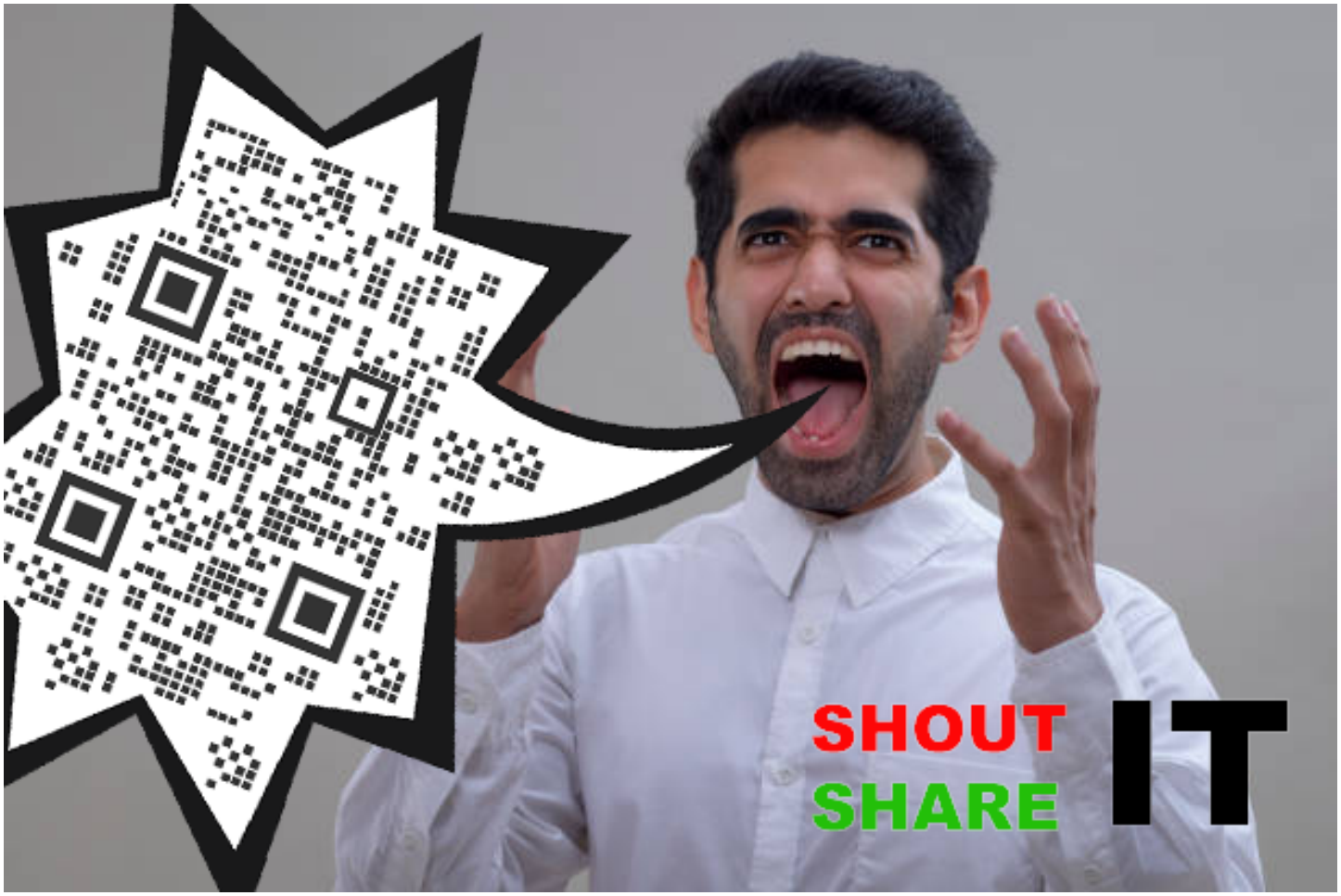
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UNITED STATES DEPARTMENT OF AGRICULTURE

BULLETIN No. 260

Contribution from the Bureau of Animal Industry
A. D. MELVIN, Chief

Washington, D. C. ▼ November 23, 1915

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U. S. Department of Agriculture

THE DOG AS A CARRIER OF PARASITES AND DISEASE.

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CONTENTS.

	Page.
Diseases and parasites carried by the dog	2
Rabies	3
Hydatid	5
Gid	9
Cysticercus (measles) in sheep and other animals	11
Diseases and parasites carried by the dog—Continued.	
Tapeworms, roundworms, etc	15
Fleas and ticks	19
Miscellaneous parasites	22
Conclusion	24

In the evolution of civilization the dog was one of the most useful animals ever domesticated by man. In addition to his usefulness, other admirable qualities have endowed him with a certain sentimental esteem as a pet. The part the dog plays as a carrier of disease, however, has only recently been recognized, and his status has not yet been changed to satisfy modern hygienic precautions or even to meet altered conditions of life in cities.

Whether in the city or in the country, the dog is commonly allowed a degree of freedom which is approached only by that of the less social and consequently less dangerous cat. Liberties which we do not allow our horses, cattle, children, or selves are extended by many persons to their dogs. They are permitted to run unquestioned over lawns or farms, to plant bones in flower beds, to litter up porches and walks with trash and filth, to lick the faces of children, to wipe their muddy paws on strangers' clothing, to go unmuzzled when rabies with its terrible agony and attendant death is abroad, and to roam afield at nights and run sheep to death.

NOTE.—This bulletin points out the increasing damage done by the stray and uncared-for dog as a carrier of parasites and disease germs harmful to both man and live stock, and is especially intended for the use of physicians, veterinarians, and health officers.

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As has been said, the dog himself has many delightful and useful qualities. It is our thoughtless tolerance of his present unwarranted liberty and license that permits this survivor of the days when the dog was man's faithful and valuable ally against the rest of the animal world to become a pest and a danger. There is a growing conviction that while his innate qualities and the fund of affectionate sentiment which attaches to him warrant the preservation of the dog with a responsible owner who will keep him clean and free from vermin of all sorts, hold him within reasonable bounds and restraint, and assume responsibility for his acts, on the other hand, the ownerless dog, the dog which carries vermin and disease, the dog which kills sheep or destroys property of any sort, the trespasser—these dogs must be eliminated.

The case against the unrestricted dog is based on two counts—that he is a nuisance and that he is dangerous.

That most dogs are allowed too many liberties and too much familiarity with people is a matter of common knowledge. Transgressions on the part of dogs range from simple trespass to the habit of biting without provocation and to the wanton killing of sheep.[1]

The direct monetary damage done by unrestricted dogs, while great, is even less important than the indirect harm they work as carriers of disease. It is the purpose of this paper to show how improperly-cared-for dogs act as agents in the spread of diseases, particularly parasitic diseases, affecting man and live stock.

DISEASES AND PARASITES CARRIED BY THE DOG.

Dogs probably play a part in the spread of diseases due to fungi, such as ringworm and favus, and are sometimes important carriers of bacterial and filterable-virus infections. In the recent outbreak of foot-and-mouth disease, it was determined beyond any reasonable doubt that dogs were responsible in some instances for the spread of the disease, not only from one farm to another, but from one State to another. The dog is of primary importance and in many instances the sole carrier in the case of many dangerous and even deadly animal parasites of man and the domestic animals, and is especially notorious as the carrier of rabies. Some of these parasites depend so absolutely on dogs as carriers during certain stages of their life history that they would probably or certainly become extinct if dogs were not available as hosts. The long list of important diseases and parasites which are conveyed by the dog to man and the domestic animals and which are present in this country is as follows: Rabies in man and stock; hydatid in man and stock; gid in stock (and possibly in man also);

[1] See Farmers' Bulletin 652, "The Sheep-Killing Dog."

muscular cysticercosis, or so-called "measles," in sheep; muscular cysticercosis, or "measles," in reindeer; cysticercosis of the liver and mesenteries in stock; tapeworm in man, especially in children; roundworm in man; tongueworm in man and stock; and fleas and ticks which transfer from the dog to man and which may in this way transmit disease and parasites. The above list is sufficient to show that the dog is of major importance as a carrier of parasites dangerous to man and domestic animals. An elaboration of the list follows.

RABIES.

It has been known for over 2,000 years that what are called mad dogs, those affected with the disease termed rabies, hydrophobia, or lyssa, could transmit this disease to stock and to man by biting them. For 2,000 years the disease has been reported in sporadic and epidemic outbreaks. It is now recognized as a widespread, acute, infectious disease of the central nervous system, characterized by extreme nervous excitability. It is a disease which, if untreated, leads to a certain death of the most horrible and agonizing sort. It owes its wide distribution and its very existence almost exclusively to the dog. The disease may manifest itself in dogs or other animals under the form of dumb rabies or furious rabies. In dogs there is commonly evidence of depraved appetite, the dog eating sticks, leather, and stones, and the finding of such things in the stomach is a suspicious indication of possible rabies. There is a partial or complete paralysis of the throat, and the resultant difficulty in drinking is the basis of the erroneous idea that the mad dog is afraid of water. As a matter of fact, such dogs are often very eager for water but are unable to swallow it. The disease seems to have some specific effect on the centers controlling biting, the feature on which transmission of the disease depends, and not only dogs but such animals as the horse show a tendency to bite when affected with rabies. The disease is suspected of being due to a parasitic protozoan, though as yet too little is known regarding this to warrant a definite statement. An examination of the brain of rabid animals shows certain cell inclusions known as Negri bodies (fig. 1), the nature of which is not at present well known.

It has been pointed out in a previous publication[1] of the United States Bureau of Animal Industry that rabies is becoming increasingly prevalent in the United States. That publication cites the fact that the New York Pasteur Institute had treated 1,608 cases of hydrophobia during the first 11 years of its existence, up to 1901. The Chicago Pasteur Institute, established at about the same time as

[1] Rabies and its increasing prevalence. By George H. Hart. Bureau of Animal Industry Circular 129. Washington, 1908.

the New York Institute, had treated 3,010 persons for hydrophobia during the first 17 years of its existence, up to 1907. The Baltimore Pasteur Institute had treated over 1,000 cases up to 1908. Many more such figures could be cited for the numerous other Pasteur

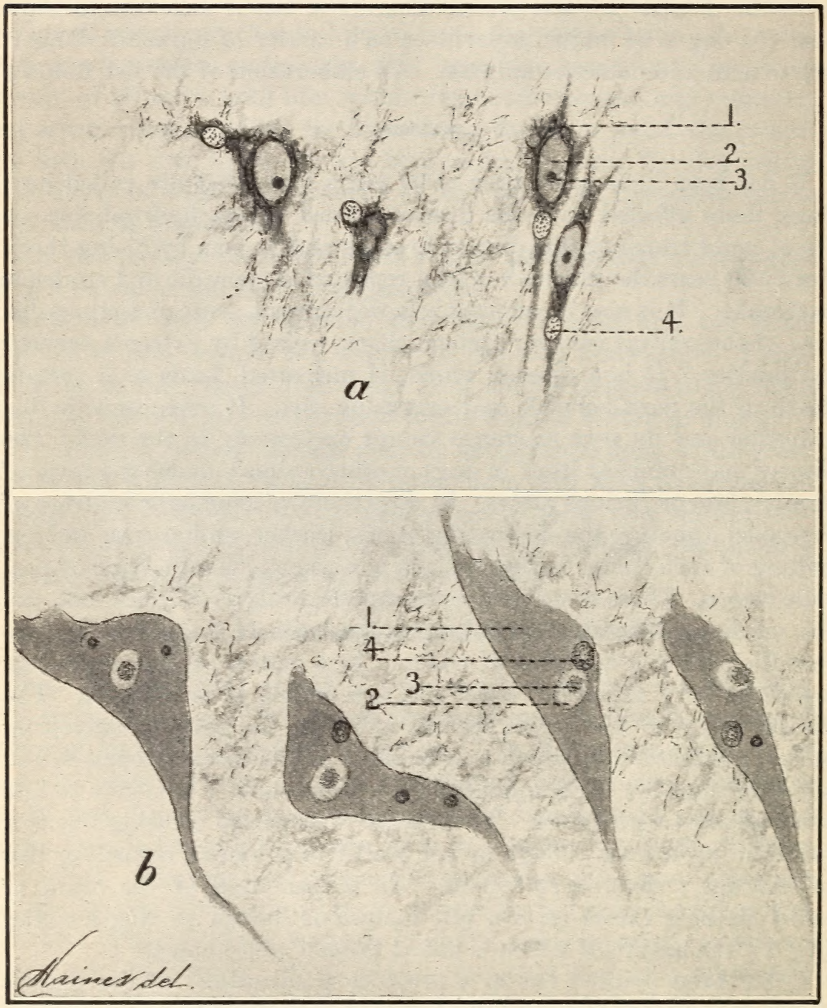

FIG. 1.—*a*, *b*, Nerve cells of the brain, showing Negri bodies, a diagnostic factor in rabies. 1, cytoplasm of cell; 2, nucleus of cell; 3, nucleolus of cell; 4, Negri body in cytoplasm of cell. (After Hart.)

institutes in this country. In 1908, 111 deaths of persons from rabies were reported in the United States, and owing to our inadequate statistical methods we have nothing like exact data in regard to the extent and distribution of the disease or the number of cases

and deaths. In 1911, according to Stimson,[1] there were 94 fatal cases in man, a decrease from the figures for 1908, which is probably due largely to the fact that in 1911 there were 4,625 persons treated for rabies in this country. Mohler[2] states that there are only three States in the Union—Idaho, Utah, and Nevada—from which it has been impossible to obtain positive information to the effect that cases of rabies have been found in them. The disease has since been reported from Idaho and Nevada.

Rabies is an easily preventable disease. In the present state of our knowledge as to its mode of transmission, there is no reason for its continued existence. It may be prevented and in time eradicated by simply muzzling dogs for a sufficient period to allow the disease to die out. Such a minor restraint on the dog as muzzling was sufficient to eradicate rabies from England. The first case since 1902 has just been reported in the spring of 1915, and this case occurred in a dog that was being held in the six months' quarantine which is enforced on all dogs brought into that country to prevent the disease being reintroduced. Australia and New Zealand have never had any cases of rabies, and a system of quarantine and inspection is provided to prevent its introduction. It has been practically or completely eradicated from Sweden, Norway, and Denmark by rigid enforcement of muzzling ordinances.

HYDATID.

Hydatid disease occurs in man, cattle, sheep, horses, hogs, and numerous other animals. It is caused by the presence of the so-called hydatid (technically known as *Echinococcus polymorphus*, *Echinococcus granulosus*, *Echinococcus multilocularis*, etc.) in such tissues as the liver, kidney, muscles, brain, lungs, etc. The hydatid is a bladder worm or larval tapeworm (fig. 2), and is characterized by its thick laminated cyst wall. The original bladder frequently develops daughter bladders on the inside or on the outside, and in these or the original bladder there develop brood capsules containing tapeworm heads. There are probably two species of hydatid, though they are commonly considered a single species. The bladder worms are often as large as an orange and may be as large as a child's head. Growth and the formation of daughter bladders may go on for an indefinite period. There have been cases in which hydatids have existed in man as long as 30 years before the death of the patient finally ensued. Their presence in the body causes various forms of

[1] Rabies in the United States during the year 1911. By A. M. Stimson. Public Health Reports, vol. 27 (28), July 12, 1912, pp. 1098–1101.

[2] Rabies or hydrophobia. By John R. Mohler. Farmers' Bulletin 449. Washington, 1911.

hydatid disease, depending on the location of the parasite. The effects are very serious and the prognosis is always grave. A conservative estimate gives a death rate of 13.6 per cent of the persons infected (Vegas and Cranwell). The growth of the bladder gives rise to various troubles as a result of pressure, obstruction, perforation of important organs, necrosis of tissue, liberation of poisonous products, secondary bacterial infections, rupture of the hydatid, and secondary hydatid infestation following rupture of the cyst. It is commonly necessary to resort to surgical interference for the removal of the hydatid. Operation is often very difficult and may have to be repeated, owing to the presence of small external daughter bladders which are easily overlooked or incapable of detection. A

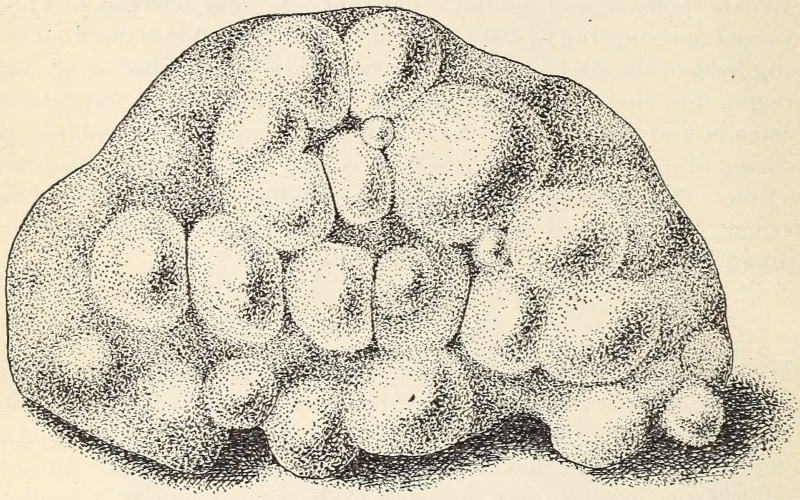

FIG. 2.—Portion of a hog's liver infested with hydatid bladderworm (*Echinococcus granulosus*). Natural size (after Stiles).

case has been recently recorded where the patient had to be operated on four times before the recurrence due to daughter bladders had ceased.

In the lower animals hydatids are probably less often a cause of death, owing to the slow growth of the parasite and the fact that the affected animals are likely to be slaughtered before sufficient time has elapsed for the parasite to become a menace to the life of the animal.

If brood capsules containing the tapeworm heads are eaten by dogs—a thing which is apt to occur on farms where the viscera of slaughtered animals, especially when they appear unwholesome, as they would in hydatid disease, are thrown out on the fields or fed to

dogs—these tapeworm heads pass uninjured to the intestine of the dog and give rise to numerous very small segmented tapeworms, *Tænia echinococcus* (fig. 3). The dog is practically the only carrier of this tapeworm. The tapeworm attains a length of only about half a centimeter (three-sixteenths of an inch) and consists of a head and three segments. The sexual organs develop in the second segment and eggs are present in the third segment. These eggs pass out in the feces of the dog and infect pasture, soil, and water. They are spread broadcast on grass, in drinking water, on products intended for human food, on children's toys, and on all sorts of objects in places frequented by the dog. The rooting habit of the hog predisposes it to hydatid disease, as it is extremely likely to swallow some of these eggs in feeding if there is a dog with the hydatid tapeworm anywhere around. But even the most careful persons have no assurance of safety where there are such dogs. Eggs from the feces of these dogs may wash considerable distances and ultimately land on lettuce, radishes, or other vegetables. They may get on the hand from contaminated tools or farm implements, or from the dog's skin. Persons who allow dogs to lick their hands or faces run the risk of acquiring and ingesting the eggs of this tapeworm. When such eggs, which are, of course, too small to be seen with the naked eye, are ingested by man or animals, the shell digests off and releases a small embryo armed with six hooks. By means of these hooks the embryo bores its way through the wall of the stomach or intestine and into the blood current. Here it is swept around till it lodges. At the point of lodgment the embryo starts to develop into the hydatid or bladder worm already noted. The parasite must always be transmitted from the dog to other animals by the ingestion of the egg from the tapeworm in the dog, and from other animals back to the dog by the dog eating diseased carcasses or parts of carcasses. It can not be transmitted in the form of the hydatid from an infected animal to another animal nor in the form of the tapeworm from one dog to another.

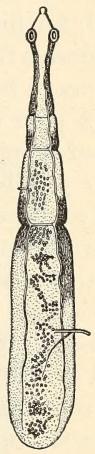

FIG. 3.—*Echinococcus granulosus* (*Tænia echinococcus*), the hydatid tapeworm from the intestine of a dog. Enlarged (after Leuckart).

Prevention depends in part on a proper handling of slaughtered animals and of those dying from any cause. An obvious aid in preventing this disease would be to destroy diseased portions of animals slaughtered for food or for any reason. This is best accomplished at

our large packing houses where such diseased portions are tanked at temperatures which insure the destruction of all parasites of any sort. On the farm it may be accomplished by boiling any viscera before feeding them to dogs or other animals. The viscera should never be thrown out on the fields. The practice is objectionable of itself; it furnishes a breeding place for flies and is in every respect insanitary and improper. Viscera and carcasses, if not cooked and fed, should be burned, buried with lime, or disposed of in such a manner that they can not be devoured by dogs.

An additional method of preventing hydatid disease, and the one that should be emphasized here, is for the owners of dogs to keep them up, and to have stray dogs disposed of by the proper authorities. A person should have substantially the same supervision of his dog's food, for his own sake and for the sake of the dog, that he has of his children's food. It is dangerous as well as unwholesome to allow dogs to forage for a living. A man who does not properly feed his dogs has a poor claim to their care and ownership. Dogs should be kept out of human habitations and treated in general with more regard to their possibilities as disease carriers.

Hydatid disease is fairly common in Europe. It is quite common in Iceland, India, Eastern Siberia, Algeria, Tunis, Australia, and some South American countries. It has been permitted to assume the proportions of a serious menace in Australia, and 3,000 cases of hydatid disease in human beings were reported from there between the years 1861 and 1882. In at least two South American countries hydatids are so common that the sanitary authorities have issued illustrated placards warning against the disease.

Over 240 cases of hydatid in man have been recorded from the United States up to 1902. Over most of the United States hydatids are comparatively infrequent in domestic animals, but they are not so rare that they are curiosities to meat inspectors. Numerous condemnations of organs and parts of carcasses are reported every year from the various meat-packing establishments under Federal inspection. Some recent abattoir figures show an alarming prevalence of this disease in domestic animals in some parts of this country, notably in certain localities in Virginia, Arkansas, and Oklahoma; and the prevalence of hydatids in domestic animals is an index of the danger to which people are exposed. It is, moreover, desirable that we apply preventive measures before a larger list of cases in man makes both curative and preventive measures imperative. The bare fact that hydatids occur at all in the United States is of itself a cogent argument for the suppression of the dog nuisance as a measure necessary for the public welfare.

GID.

Gid disease, like hydatid disease, is due to the presence of a bladder worm, or larval tapeworm, in the tissues. The bladder worm (known as *Multiceps multiceps* or *Cœnurus cerebralis*) (fig. 4) which causes gid resembles the hydatid bladder worm in that one bladder worm may produce large numbers of tapeworm heads, and the tapeworms resulting from these heads occur in the intestines of dogs, as in the case of the hydatid tapeworm. The bladder worm causing gid differs from the hydatid in that it has a thin, delicate, membranous wall instead of a thick laminated wall; it does not produce daughter cysts as the hydatid does, and it occurs only in the brain and spinal cord instead of in any tissue. The adult tapeworm in the dog, commonly known as *Tænia cœnurus* (fig. 5) attains a length of 2 or 3 feet instead of a small fraction of an inch.

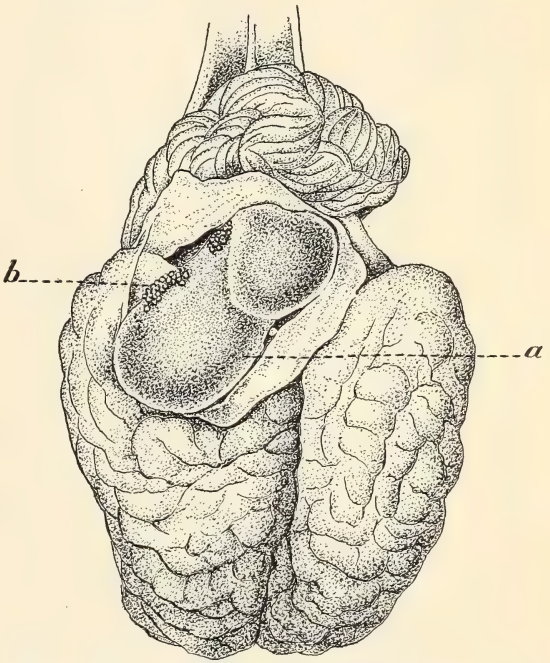

FIG. 4.—Brain of giddy sheep, showing gid parasite. *a*, Gid parasite or bladder worm; *b*, heads on bladder worm. (After Numan, 1850, Pl. I, fig. 1.)

Gid is principally a disease of sheep, though it is fairly common in cattle and there are some cases from the horse and the goat. In 1910[1] the writer stated that there were no valid cases of the disease in man. Since then Brumpt[2] has published one case which apparently must be accepted as a good case.

The life history of the gid parasite is practically the same as that of the hydatid. The gid bladder worm is called a cœnurus. When this cœnurus is eaten by a dog, the tapeworm heads on the cœnurus pass to the intestine of the dog and give rise to a tapeworm which

[1] The gid parasite and allied species of the cestode genus *Multiceps*. I. Historical review. By Maurice C. Hall. Bureau of Animal Industry Bulletin 125, pt. 1.

[2] Précis de parasitologie, 2d ed., pp. 281–283. 1913.

may attain a length of 2 or 3 feet. In the terminal segments are eggs, and these segments with the contained eggs pass out in the feces of the dog and contaminate vegetation, soil, and water. Such herbivorous animals as sheep, which graze over range or pasture contaminated in this way, pick up these eggs as they feed and swallow them. In the stomach of the sheep the shell is digested and the small, hooked embryo released. The embryo bores its way through the wall of the digestive tract and into the blood vessels and is carried around until it lodges somewhere. Embryos which do not lodge in the central nervous system start to grow, but very soon perish. Very commonly, however, the parasite makes its way to the central nervous system, lodging as a rule in the brain, though it occasionally occurs in the spinal cord. In the brain the embryo grows to form the bladder worm or cœnurus, and this may attain the size of an egg, or even a larger size. As it grows it presses upon the adjacent portion of the brain and destroys it. The pressure and the irritation, due to the hooks with which the tapeworm heads of the cœnurus are provided, cause very distinctive symptoms, the sheep commonly holding its head in an odd position and walking in a circle toward one side or the other. Unless the cœnurus is removed by operation the sheep invariably dies. When the brain of such a sheep is eaten by dogs—and dogs very readily eat the brains of sheep by licking them out through the large opening at the base of the skull—the cœnurus is ingested with the brains and the tapeworm heads pass to the intestines of the dog and give rise to the adult tapeworms. As in the case of the hydatid, the gid parasite must always be transmitted from the dog to other animals which eat the eggs from the dog tapeworm, and from the other animals to the dog by the dog eating the brain or at least the cœnurus from the brain of a giddy animal.

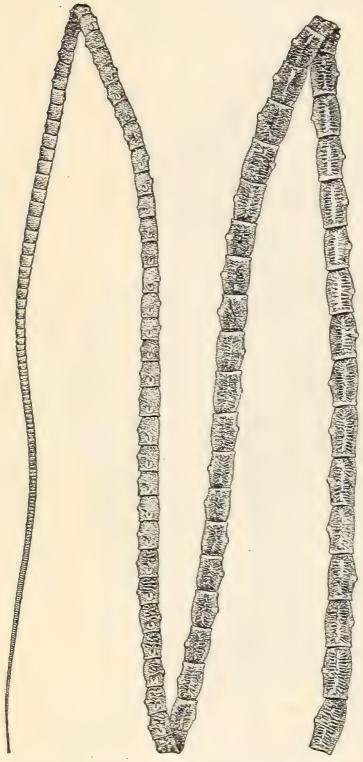

FIG. 5.—Adult gid tapeworm from the dog. Natural size. (Specimen No. 4031, Bureau of Animal Industry helminthological collection.)

One preventive measure for suppressing gid is, of course, to destroy the brains and the cœnuri of giddy animals, which can be done by burning them or by breaking the skull and covering the brain with formaldehyde, sheep dip, or some similar substance. Another measure is to administer a vermifuge to sheep dogs and so rid them of their tapeworms, and to do this often enough to keep them free from tapeworms. But it is obviously of little avail to a sheepman to have his own dogs free of tapeworm if his neighbor's dogs or ownerless dogs or strays of any sort are free to carry tapeworm onto his range or pasture and infect the grazing and thereby infect his sheep. From losses originating in this way he must be protected by measures looking to the restraint of dogs that recognize an owner and the elimination of those that do not.

Gid has been reported from several States in this country, but it is most prevalent in Montana, especially in the northern half of that State, where gid has had a foothold for a quarter of a century and where the losses for some years total about $10,000. There is evidence of the occurrence of gid in Arizona, and outbreaks have occurred in recent years in New York, Iowa, and Kansas. There have been reports, apparently correct, of its occurrence in Ohio, Illinois, Michigan, Missouri, Oklahoma, and Nevada. It is a constant source of loss in many European countries, and at various times has proved a veritable scourge to the sheep industry of these countries.

CYSTICERCUS (MEASLES) IN SHEEP AND OTHER ANIMALS.

Muscular cysticercosis ("*measles*") *in sheep.*—The presence of small bladder worms in mutton has recently been shown by Ransom[1] to be much more common than had been suspected, and to be due to a tapeworm in the dog and not to a tapeworm of man as had been supposed. His investigations showed that under careful inspection the percentage of affected sheep in this country has amounted to 2 per cent or more, and that approximately 20,000 sheep carcasses were retained in 1912 in abattoirs under Federal inspection on account of "sheep measles" due to this parasite.

The bladder worm, *Cysticercus ovis* (fig. 6), in the meat of sheep is oval and ranges in size from about one-third of a centimeter (one-eighth of an inch) to almost a centimeter (three-eighths of an inch) in length. Inside of this bladder there is a single tapeworm head, in which respect, as well as in size, this cysticercus, as it is called,

[1] *Cysticercus ovis,* the cause of tapeworm cysts in mutton. By B. H. Ransom. Journal of Agricultural Research, U. S. Department of Agriculture, vol. 1, pp. 15–58. 1913.

differs from a hydatid or a cœnurus. Numerous cysts, however, may be scattered through the musculature, so that in their numbers there is a compensation, so to speak, for their small size and lack of a multiplicity of heads. Inasmuch as the presence of these cysts calls for condemnation of a part or all of the infested carcass, according to the degree of infestation, and the number of carcasses amounts to 20,000 a year, this parasite has considerable economic interest for

FIG. 6.—Bladder worm (*Cysticercus ovis*), a tapeworm cyst infesting the meat of sheep. (From Ransom.)

this country, and never more than at the present time when the "high cost of living" is such a vital topic.

When one of these cysticerci from mutton is ingested by a dog, the tapeworm head passes undigested to the dog's intestine and develops into a fairly large tapeworm, comparable to the gid tapeworm. Similarly, this tapeworm, *Tænia ovis* (fig. 7), produces eggs which are passed out in the feces of the dog, and which are ingested

by sheep as they graze over range or pasture or drink water contaminated by these feces. In the sheep the eggshell is digested, the released embryo bores through the tissues and comes to rest usually in the edible musculature, and the bladder worm develops to the cysticercus capable of again infecting the dog. In cases of heavy infestation sheep are liable to die in the course of two to three weeks, but as a rule the health is not perceptibly affected. Here, as in all similar cases, the parasite must pass from the dog to the sheep and from the sheep to the dog.

FIG. 7.—Tapeworm (*Tænia ovis*) developed by feeding bladder worm (*Cysticercus ovis*) to a dog. (From Ransom.)

The parasite has been found in Europe, Africa, and New Zealand. It has been found thus far in seven States in this country. It appears to be particularly prevalent in the West, a fact that is possibly related to carelessness on the part of the western sheepmen as regards the disposal of carcasses of sheep dying on the range. Such sheep are usually left lying where they die, a practice which aids in the spread and continuance of gid, and which serves the same purpose in the case of the "sheep measles" parasite that throwing diseased viscera of hogs onto the fields does in the case of the hydatid parasite. The sheep dog is probably the principal carrier of the parasite,

so that neglect on the part of sheep owners is a leading reason for its prevalence.

The prophylactic measures against "sheep measles" are essentially the same as those against gid and hydatid. Diseased portions of slaughtered sheep and dead sheep which have not been slaughtered should be cooked before being fed to dogs or else disposed of so that dogs can not eat them. Ownerless dogs should be destroyed and other dogs properly fed and kept free from tapeworm.

Muscular cysticercosis ("measles") in reindeer.—This parasite deserves special mention in view of the possibility that the Alaskan reindeer may become important in connection with the meat supply of this country. A large percentage of these animals, which are rapidly increasing in numbers, are infested with a measle parasite apparently the same as the form known to be the intermediate stage of a dog tapeworm (*Tænia krabbei*). This is not only serious so far as concerns the reindeer industry, but the possibility that the parasite may become established in other food animals is not altogether excluded, though probably remote. *Tænia krabbei* occurs in Europe and Asia and was likely introduced with the reindeer or dogs imported into Alaska, though the Alaskan form may be a native parasite already present in American reindeer and carnivores before the importation of the Old World animals.

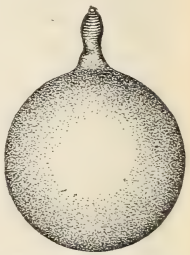

FIG. 8.—*Cysticercus tenuicollis*, the thin-necked bladder worm from the body cavity of cattle, sheep, swine, etc. Natural size (after Stiles).

Cysticercosis of livers and mesenteries.—Cysticercosis, or the presence of cysticerci, or bladder worms, in the livers, mesenteries, and omentum or "fat caul," is very common in cattle, sheep, and hogs throughout the United States. These bladder worms, *Cysticercus tenuicollis* (fig. 8), are usually 1 or 2 inches in diameter, and the cyst contains a single tapeworm head. The life history follows the same general plan that has been outlined for the preceding tapeworms. When such bladder worms, or viscera containing them, are eaten by dogs, the head contained in each cyst passes to the intestine and develops a tapeworm (*Tænia hydatigena* or *Tænia marginata*) (fig. 9) in the dog; the eggs produced by the tapeworm pass in the feces of the dog onto the vegetation or into the drinking water of cattle, sheep, and hogs; the eggs ingested by these animals in feeding or drinking release an embryo which makes its way, via the portal system, from the digestive tract to the liver; in the liver the embryo develops into a small bladder worm (*Cysticercus tenuicollis*) which after some time slips from the liver into the body cavity and lodges in the omentum or mesenteries, where it attains its final growth; the bladder worm may then be eaten by a dog, on the death of the host

animal in which the bladder worm occurred, and will give rise to a large tapeworm, which may attain a length of 5 meters, or about 16 feet.

Extensive burrowing of the parasites in the substance of the liver during the early period of the bladder-worm development may cause serious damage, and in cases of heavy infestation may result in the death of the animal. Bacterial infection may complicate the parasitic invasion. In the United States, flocks of sheep in which this parasite is not present are rare, and a high percentage of livers, especially lamb livers, are condemned in abattoirs under Government inspection because of infestation with this parasite.

Prevention calls for a proper disposal of the viscera of slaughtered animals with a view to keeping the viscera, unless first properly cooked, away from dogs. It also calls for a routine tapeworm treatment for dogs, an adequate knowledge and supervision of the food and feeding habits of dogs, and the elimination of the dog without a responsible owner.

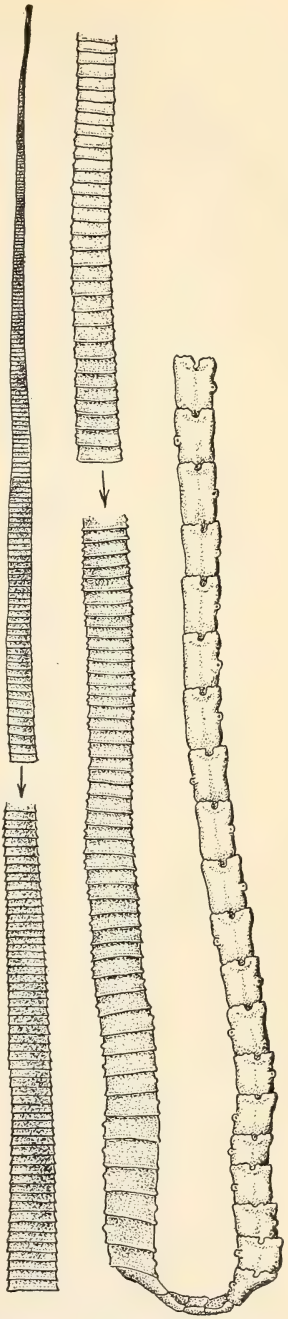

FIG. 9.—*Tænia hydatigena*, the adult tapeworm from the intestine of the dog. Natural size (after Stiles).

TAPEWORMS, ROUNDWORMS, ETC.

Double-pored tapeworm.—Of the numerous species of tapeworm occurring in the dog, many of them not mentioned in this paper because they do not have a larval stage or bladder worm in man or stock, one species may occur in man in the form of the adult tapeworm. This species, commonly known as the double-pored tapeworm (*Dipylidium caninum*), has a life history which follows the same general plan of alternation, from a tapeworm in the dog to a larval tapeworm in an intermediate host and back to the dog, that the tapeworms already mentioned follow. It is, however, peculiar in that the intermediate stage,

or larval tapeworm, is very small and develops in the dog flea or louse instead of such an animal as the sheep. The flea or louse ingests the eggs of the tapeworm by biting the skin of the dog where it is contaminated by the feces of the animal or by soil containing eggs from the feces, or possibly by biting the tapeworm segments containing the eggs as these segments pass from the dog. Within the flea or louse the egg develops into a larval tapeworm, necessarily a very small larva, known as a cryptocystis. Owing to the pain and irritation resulting from the bites of these fleas and lice, the dog will from time to time root out the offenders and inadvertently or intentionally, as the case may be, swallow them. In the stomach of the dog the fleas and lice are digested and the little tapeworm larva set free to pass on to the intestine and develop into a tapeworm, which may attain a length of 35 centimeters, or about 14 inches.

When flea-infested or lousy dogs are allowed unwarranted privileges in the house, permitted to put their paws on the table during meals, to eat from the same dinner plates and saucers, to lick the baby's face and the children's candy, to sleep at the foot of a person's bed or on a pillow near a person's head, the chance of a flea landing unperceived in food that will hold and conceal the flea, the chance of its getting to the baby's mouth or adhering to the sticky candy which the child eats with no regard to incidental contamination, is very good. Under such conditions the ingestion of fleas or lice infested with the larval tapeworm in question is likely to occur, and the result is the development of the adult tapeworm in the person ingesting them. This tapeworm has been found in children more frequently than in grown persons, in one case in a baby only two months old, but it has been found in an adult 38 years old. As many as 238 worms have been found in a single person. Up to date, 76 cases of this tapeworm in man, usually in children, have been reported, and a number of these are from the United States.

The remedy here concerns the family dog rather than the stray. The dog should be treated like a dog, not like a person. The dog is an animal with its habits fixed by all the facts that arise from the one fact that it is a dog. The fact that a dog is not a person, that it is different from people, is important. The lack of hands compels the dog to use his tongue for a wash rag, but we are under no such necessity, and there is nothing in the situation that calls for our permitting our own or our neighbor's dog to use the same tongue subsequently on our hands or face. It is an absurdity to ask that the cook and the table service be clean and then allow a dog to put his feet on the table, to sniff at the food, to lick the hand or face, and to

do the dozens of other dangerous and improper things that some dogs are allowed to do.

The presence of one or a few of these tapeworms in man probably occasions very little inconvenience as a rule. At the same time the tapeworm has an unpleasant habit of burrowing through the intestinal mucosa, thereby destroying its integrity and exposing it to the attack of any pathogenic germs that may be present in the intestine. The same burrowing habit makes it difficult to remove successfully the entire worm with the head, and a failure to remove the head, owing to its being buried in the mucous lining of the intestine, results in the subsequent development of new tapeworm segments from the head and a renewal of infection. At its best, a tapeworm is a thing unpleasant to contemplate as an inhabitant of our intestines. The presence of the tapeworm under discussion here is, moreover, evidence of careless or unclean habits on the part of the person infested.

Prevention requires that the unwarranted liberties and freedom of the dog be curtailed; that he be kept free not only from tapeworm but from such external parasites as fleas and lice. The accomplishment of the latter measure calls for keeping a dog clean and restraining him so that he will not be allowed to run at large with vagrant flea-infested and lousy dogs.

Roundworm.—Among the other parasites of the dog there is a nematode or roundworm, scientifically known as *Toxascaris limbata*, which, like the tapeworm just mentioned, may occur in man in the same form in which it occurs in the dog. This worm does not have an intermediate stage in another animal, but is conveyed directly through the eggs produced by the female worm, which eggs normally convey the infection from a dog back to the same or another dog, either in contaminated food or water or as the result of the contamination of the skin and the subsequent cleansing of the skin by means of the tongue.

Under the conditions of unwarranted association and familiarity with dogs already mentioned, eggs of this parasite and of an allied parasite in the cat may be ingested by man, and especially by children, and subsequently develop into the adult worm in the intestine. These worms may produce unpleasant results. The entire group of ascarids are notorious for their wandering habits. They not infrequently travel to the stomach and produce vomiting, in the course of which the worms may be brought up. It is hardly necessary to say that the vomiting of worms 4 or 5 inches long is a distinctly unpleasant experience, and this is one of the least unpleasant results

of such infestation. Ascarids at times enter the appendix and cause appendicitis; they may perforate the intestine and cause peritonitis; they may come up the esophagus and get down the windpipe, with a resultant suffocation, or enter the eustachian tube of the ear. These are unusual cases for the most part, but they are dangers to be considered. There are other unpleasant and dangerous features of ascarid infestation, and the uncomfortable certainty that their presence is undoubtedly indicative of fecal contamination of food, drink, or ingesta of some sort.

The prophylaxis in this case, as in the case of the previously mentioned worms, depends on keeping dogs free from worms and restricting their privileges in the household and in their relationship to human beings.

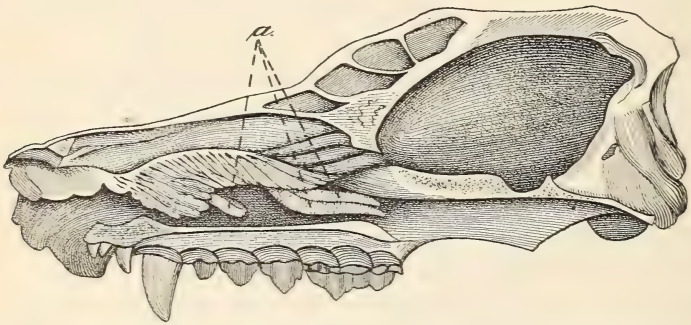

FIG. 10.—Head of a dog split in half to show three tongueworms (*Linguatula rhinaria*), *a*, in the nasal cavity. Reduced in size (after Colin).

Tongueworm.—The tongueworm, *Linguatula rhinaria* (*Linguatula serrata*) (fig. 10), occurs in the adult stage in the nasal passages and frontal sinuses of the dog. It is light colored and shows an external, ringlike segmentation. The male may attain a length of 20 millimeters (about three-fourths of an inch) and the female may attain a length of 100 millimeters (about 4 inches). The eggs deposited by the female leave the nostrils of the dog in the catarrhal secretion occasioned by the presence of the parasite, some of them doubtless being sneezed out, and contaminate the vegetation on which they at times lodge. Such vegetation may be eaten by cattle, sheep, horses, or swine, or if the infested dog has access to a truck garden or a family vegetable garden, contaminated lettuce, cabbage, etc., may be eaten by man. When the eggs get to the stomach the shell is digested off, releasing a peculiar embryo which shows by its structure that these tongueworms are really related to the mites, a group of spiderlike animals. This embryo makes its way through

the walls of the intestine and encysts in the lungs, liver, kidney, lymphatic glands, etc., where it develops to the larval stage (fig. 11). Subsequently they break out of their cysts and resume their migrations, wandering through the tissues, causing more or less damage, until they reach the abdominal or thoracic cavity, sometimes entering the intestines and bronchi, and at times causing the death of the host. Just how they get from here to the nasal passages of the dog is not very well known, though it is certain that this takes place. Possibly larvæ are at times sniffed up by the dogs as they nose through an infested carcass; possibly in eating such a carcass larvæ pass directly from the mouth of the dog back to the posterior portion of the nostril by way of the pharynx, or the parasite may return from the stomach by way of the esophagus. The adult worm has been reported, but very rarely, from the nasal passages of man.

The larvæ are apt to be overlooked in necropsies on the human cadaver, but have been recorded in as high as 25 per cent of necropsies. In various localities in Germany they are commonly present in 3 to 4 per cent. This is a widely distributed parasite, and is found from time to time in the United States. A case in man has been recorded from the Canal Zone.

Prevention consists in keeping viscera of animals away from dogs, unless the viscera are cooked, and in a reasonable attention to what a dog eats, and this involves a responsible supervision of the dog's wanderings and conduct in all respects.

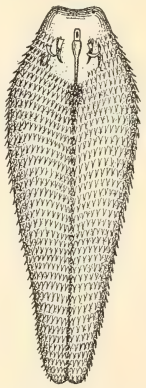

FIG. 11.—*Linguatula rhinaria*, the larval tongueworm from the liver and lymph glands of cattle, sheep, etc. Enlarged ten times (after Railliet).

FLEAS AND TICKS.

Fleas.—In the western United States investigations indicate that the commonest flea attacking man is the so-called human flea, *Pulex irritans*, of which man is the primary host. The same investigations indicate that the dog is a most important carrier of that flea, probably the most important. Of 456 fleas collected from dogs in Berkeley, Cal., 29 per cent were of this species. In the eastern United States investigations indicate that the commonest flea attacking man is the so-called dog flea, *Ctenocephalus canis* (fig. 12), and here, of course, the dog is the normal host and the usual carrier.

Either species of flea constitutes an annoying pest. The bite is distinctly unpleasant and in the summer nights may prove just the

additional irritant which makes sleep impossible. Equally as important as the annoyance is the fact that fleas of all sorts are under suspicion at present as possible carriers of bacteria, parasites, and diseases of various sorts. We know that the dog flea and the human flea, as well as the rat flea, are capable of transmitting bubonic plague to man; that the dog flea, as already noted, transmits the tapeworm *Dipylidium caninum* to man; and we are warranted in suspecting that additional study will add other counts to this indictment against fleas. In the meantime our actual knowledge and strong suspicion are ample grounds for avoiding fleas and the flea-bearing

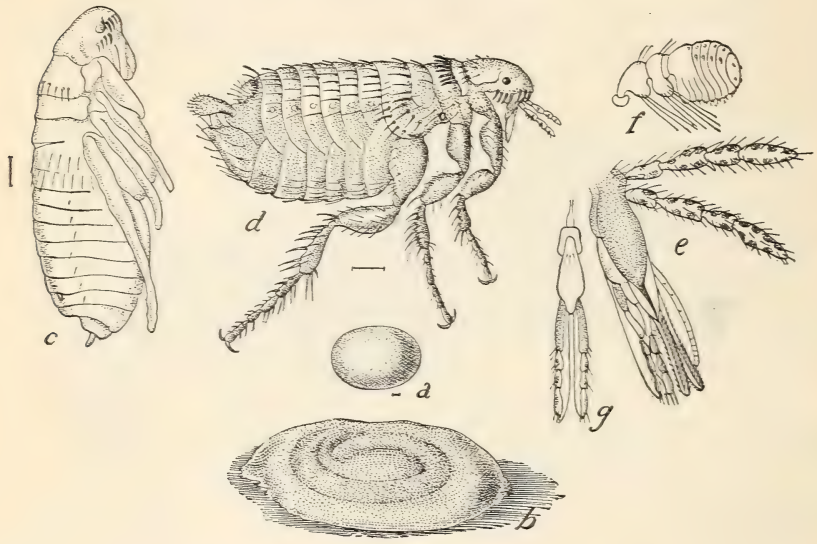

FIG. 12.—Dog flea (*Ctenocephalus canis*): *a*, Egg; *b*, larva in cocoon; *c*, pupa; *d*, adult; *e*, mouth-parts of same from side; *f*, antenna; *g*, labium from below. *b*, *c*, *d*, Much enlarged; *a*, *e*, *f*, *g*, more enlarged. (From Howard, Bureau of Entomology.)

dog. It is comparatively easy to avoid annoyance from fleas in the absence of dogs or cats around a dwelling. Where dogs and cats are present it is more difficult and the animals must be closely watched and given appropriate treatment from time to time. For adequate protection it is essential that stray dogs and dogs belonging in the neighborhood should be prevented from becoming habitual visitors and utilizing the porch and hammock as sleeping quarters.

The chicken flea (*Echidnophaga gallinacea*), a common pest in some of the Southern States, frequently infests dogs. Here, again, the remedies lie in the proper handling of dogs by their owners and the elimination of ownerless dogs or dogs whose irresponsible owners

take no care of them. Under proper conditions of restraint dogs may be rid of fleas and kept free from them.

Ticks.—In this country the dog is known to be the usual or occasional carrier of 11 species of ticks, almost all of which are also occasional or habitual parasites of man or stock. In this way the dog serves the tick by furnishing it with nourishment and also aids in spreading infestation, conveying ticks in this way to man much more effectively than other animals are able to do, for the reason that there is no other animal in such close contact with man, with so many liberties, and with such a wide and unrestrained range during the periods when it is not with its owner. These habits of the dog make it an object of suspicion in connection with tick-eradication work. Such ticks as *Dermacentor variabilis* (fig. 13), which are common on the dog, are brought into houses rather frequently and have many opportunities to attack man. Such ticks as the spotted-fever tick, known as *Dermacentor andersoni* or *Dermacentor venustus* (fig. 14), are seldom found on dogs, but in view of the fact that the bite of one tick may result in spotted fever and the death of the person bitten, even such infrequent transmission by dogs must be guarded against. This tick is known to occur in Montana, Wyoming, Colorado, New Mexico, and the States west of these, with the exception of Arizona. Spotted fever is known to occur in a number of these States, and with the tick present its occurrence and spread in the other States depend merely on the chance of a carrier of some sort coming into them under conditions which will permit of the tick having access to the carrier and to other animals or persons. Dogs may also carry the Texas-fever tick (*Margaropus annulatus*), and some species of ticks possibly depend on the dog for their continued existence.

FIG. 13.—American dog tick (*Dermacentor variabilis*); male, dorsal view. (From Hooker, Bishopp, and Wood, Bureau of Entomology.)

FIG. 14.—Rocky Mountain spotted-fever tick (*Dermacentor andersoni*, or *D. venustus*); male, dorsal view. (From Hooker, Bishopp, and Wood, Bureau of Entomology.)

Dogs which are kept free of such vermin as ticks by frequent baths or other necessary measures and which are not allowed to wander at will are reasonably safe from the standpoint of spotted fever or other tick conveyance to man or stock. They are at least much safer than those which are neglected, allowed to accumulate internal and external parasites, and to carry and convey the same without hindrance.

MISCELLANEOUS PARASITES.

In the foregoing part of this paper only those injuries, parasites, and diseases traceable to the dog which are known to occur in the United States have been mentioned. It should be stated, however, that the dog is known to have quite a large number of other parasites, some of them already present in this country, which have been found in man and stock in foreign countries, sometimes as rare and unusual occurrences and sometimes very common and even in the form of endemic, constantly present diseases. Inasmuch as almost all of the parasites heretofore mentioned originated in foreign countries and were brought here, and since we have no guaranty and but little protection against others being brought here, it will be worth while to name some of the other parasites of which space forbids a detailed discussion. Some of the parasites mentioned below have been found in the dog only as a result of experimental infestation, which is, however, proof that they might occur in nature under suitable conditions of transmission. Some of these diseases, owing to the nature of the life history, possibly could not obtain a foothold in this country, but many of them certainly could.

Protozoa.—The dog has been reported as a carrier of the following protozoa: *Entamœba dysenteriæ*, the cause of amebic dysentery in man; *Lamblia intestinalis*, a flagellate protozoan which is rather common in man in the United States; *Trypanosoma evansi*, which is the cause of surra, a disease of horses, cattle, etc., which has not yet been introduced into this country, but which has been detected at the quarantine station and kept out of the country by the United States Bureau of Animal Industry on one occasion; *Trypanosoma brucei*, which is the cause of nagana, a disease of horses, cattle, etc., which occurs in Africa; *Trypanosoma equinum*, which is the cause of mal de caderas, a disease of horses in South America; *Trypanosoma dimorphon*, which causes a disease of horses, cattle, etc., in Africa; *Trypanosoma pecaudi*, which is the cause of baléri, a disease of horses in Africa; *Nuttalia tropica*, which is the cause of a piroplasmosis of horses and cattle in India; *Leishmania furunculosa* (*L. tropica*), which is the cause of Oriental sore, a disease of man which has recently been reported from this continent at Panama;[1] *Leishmania*

[1] Oriental sore in Panama. By S. T. Darling. Arch. Int. Med., Chicago, v. 7, May, 1911, pp. 581–597.

infantum, which is the cause of infantile splenomegaly, a serious, commonly fatal disease of children in Italy and Tunis; *Leishmania donovani*, which is the cause of tropical splenomegaly, a serious disease of adults in India, China, and the Sudan; *Leishmania braziliensis*, which is the cause of a disease of man in South America; *Spirochæta aboriginalis*, which is the cause of granuloma inguinale in man in British Guinea and Australia; and of some other protozoan forms of which the record or the identity of the form in the dog with those in man or stock is still uncertain. A useful object lesson may be drawn from the fact that the destruction of stray dogs in one small island in Italy has resulted in a remarkable reduction in the prevalence of infantile splenomegaly in that locality. This terrible disease is apparently spread from dogs to children by fleas.

In addition to the above-mentioned protozoa there are a number of worm and arthropod parasites carried by the dog and attacking man or the domestic animals, which have not been discussed in the first part of this paper because of their absence from or comparative infrequency or unimportance in this country. A brief note of these forms is given here.

Tapeworms.—As regards tapeworms, the dog shares with man the responsibility for carrying the broad fish tapeworm, *Diphyllobothrium latum* (*Dibothriocephalus latus*), a tapeworm of considerable medical importance, which is known to be established in this country, and both carry an allied tapeworm, *Diphyllobothrium cordatum*. The dog is also an occasional host of the pork measle parasite (*Cysticercus cellulosæ*), the larvæ of one of the tapeworms of man. The dog becomes infested with this parasite by eating the feces of the human host of the tapeworm. It has also been shown to act as the host of an adult tapeworm having a *Sparganum* larva in the hog, and may be the host of other related tapeworms belonging to this group.

Flukes.—The dog is reported as the carrier of the following flukes: *Paragonimus kellicotti*, which occurs in the lungs, causing parasitic hemoptysis in hogs in this country; *Clonorchis sinensis* and *Clonorchis endemicus*, which occur in the liver of man and hogs in China and Japan; *Heterophyes heterophyes*, which occurs in the intestine of man in Japan and Egypt; *Dicrocœlium dendriticum* (*D. lanceatum*), which occurs in the bile ducts of man and of horses, cattle, sheep, hogs, etc., and which is common in various foreign countries, though not as yet known from the United States; *Schistosoma japonicum*, which occurs in the blood of man in Japan, China, the Philippines, and South Africa; *Opisthorchis felineus*, which occurs in the liver of man in Asia; and of *Opisthorchis noverca* and *Pseudamphistomum truncatum*, also parasites of man.

Nematodes.—As regards nematodes, the dog is one host of *Dracunculus medinensis*, the Guinea worm, which is not known in this

country, and is the usual host of *Dioctophyme renale*, the giant kidney worm, which is a huge red worm a yard long and as thick as a little finger, occurring in the kidney or abdominal cavity of man, the cow, the horse, and the hog. This last-named worm has been found in this country on a number of occasions. *Strongyloides stercoralis*, the parasite of Cochin China diarrhea, can be readily transmitted to dogs, and a *Strongyloides*, apparently this species, is found in dogs in China and Japan.

Mites, fleas, etc.—The dog is affected by a form of mange or scab due to a mite known as *Sarcoptes scabiei canis*. This disease occurs in this country and may be transmitted to man, causing more or less discomfort. The dog is also known to be attacked by and transmit the sarcoptic scab of sheep, a rather rare form of scab due to the mite *Sarcoptes scabiei ovis*.

In addition to being the adult host of the aberrant spiderlike form, *Linguatula rhinaria*, the larva of which may occur in man, the dog is a host for the larval form of two closely related species, *Porocephalus armillatus* and *P. moniliformis*, which may also pass their larval stage in man.

The dog is not only a host for the cosmopolitan fleas *Pulex irritans* and *Ctenocephalus canis*, but is also a host for the widely distributed chigger flea, or chigoe, *Dermatophilus penetrans* (*Sarcopsylla penetrans*), of tropical countries and native in the southern portion of North America. This flea attacks men, cattle, horses, mules, sheep, goats, and hogs, the female becoming embedded in the skin and growing to the size of a pea.

Finally, the dog is an important host of the parasitic larvæ of certain flies which also habitually attack human beings and live stock. One species, *Dermatobia cyaniventris*, occurs in South and Central America, and another, *Cordylobia anthropophaga*, occurs in Africa. These larvæ undergo their development beneath the skin, causing boil-like tumors and abscesses. Another species, *Paralucilia macellaria* (*Chrysomyia macellaria*), is a serious pest in the southern United States. Its larvæ, commonly called screw worms, attack cattle, horses, and other animals, including dogs and human beings. These screw worms may undergo their development in the carcasses of dead animals as well as in the tissues of live animals.

CONCLUSION.

The parasites discussed in this paper do not nearly exhaust the list of those present in the dog, but only those known also to affect man or live stock.

In conclusion it may be said that the dog is at present the subject of numerous criticisms from three quarters. For over half a century

parasitologists have been insisting that the dog is so largely responsible for the spread and so essential to the existence of so many important parasites that we must curtail his liberty and guard him, ourselves, our families, and our stock from the evil results of his unrestrained wanderings.

For a number of years public-health officers and others who have the welfare of the community at heart have been insisting on a restriction of the dog's unwarranted liberty in order to lessen and in time to eliminate the terrible menace of rabies.

More recently the sheepmen who have been accustomed to keeping out of business in localities where there were too many dogs, or who have permitted themselves to be forced out of business as a result of the attacks of sheep-killing dogs and the resentment and antagonism of the dogs' owners, have been taking more aggressive action and have started a propaganda looking toward the elimination of the worthless dog and the placing of full responsibility for other dogs on their owners.

It is to be hoped that the coordinate action of these persons and others interested in the safeguarding of life, health, and property will soon bring about positive and valuable results.

In a general way there are three kinds of dogs—the vagrant, ownerless stray; the other person's dog; and your own dog.

The stray dog which recognizes no owner must be eliminated. The irresponsible dog with no owner to care for him, to look after his health as it concerns the dog and other animals and man, and to restrain him and stand sponsor for his acts and especially the damage he may do—such a dog does not fit into a scheme of civilization which is based on law and the responsibility of individuals for themselves and others.

We have a right to insist, and should insist, that the other person's dog keep off our premises. A dog that is allowed by the owner to wander at large will have substantially the same habits of life, the same sort of food, and be substantially as dangerous as the ownerless dog. Such a dog is not only a trespasser but a potential menace whose visits may incur loss of money, health, or even life.

Your own dog should be handled in such a way as best to further the welfare of the dog and the community. He should be kept in restraint and not allowed the full freedom of the house or even of the outside premises. He should not be allowed to be familiar with people, and especially with children. The dog should be kept free from external parasites by frequent baths and, if necessary, other appropriate measures, and should be freed from internal parasites by suitable measures and kept free by adequate attention to his food. He should only be allowed to leave the yard or the kennels in company

with some person, and wherever conditions call for it should be kept in leash. When away from home the dog should be muzzled with a reliable metal muzzle, not with a strap muzzle that would be cruel to the dog if tight enough to be effective and which is usually so loose as merely to give a false sense of security, since it permits the dog to bite.

In regard to laws requiring muzzling and other restraints, Schroeder[1] has made the following interesting comment:

> The reason why laws of this nature have not been made is due to the active fight against them by a small, greatly interested minority that opposes a tardy, disinterested majority. The minority fights hard for a privilege it has long enjoyed and abused, that of allowing dogs to be at large without restraint at all times, and the majority has never half realized that this privilege is costing a high price in the destruction of property and in horrible agony and numerous deaths. * * * The dog owner who knows what rabies is from experience, if he has the proper consideration for his own welfare and that of his dogs, will be among the first to demand a movement for its suppression, even if this should place restrictions on the freedom of his own dogs. His interest is greatest because he has the most at stake and is himself most seriously and frequently exposed to the infection.

As means or adjuncts for attaining the conditions outlined here, numerous measures have been suggested and, to some extent, practiced in this country. Some of these measures are cited in a paper by Stimson,[2] and a very good summary has been given by him. Among the possible measures are, of course, the imposition of a license on all dogs, dogs so licensed to wear an official tag with at least a registered serial number on it, and possibly with the owner's name and address also. Any dog not so licensed should be taken up by an adequate impounding force and humanely killed. Dogs so licensed should be taken up when found astray in violation of ordinances requiring muzzling or imposing other restrictions. Rabies should be made a reportable disease everywhere, and prompt and thorough measures taken for its eradication, to be followed by quarantine against unrestricted importation of dogs into clean areas. Castration and spaying are recommended as aids in keeping a dog at home. They also serve to stop the promiscuous breeding which serves to add recruits to the vast army of worthless and vagrant dogs. Dr. Arbuckle, in recommending castration, says that it does not diminish the animal's value as a hunting dog.

Protection from the dangers of improperly controlled dogs depends primarily on the education of the public and the development of an educated public sentiment. With public sentiment behind it any re-

[1] Some observations on rabies. By E. C. Schroeder. Bureau of Animal Industry Circular 120. 1908.

[2] Facts and problems of rabies. By A. M. Stimson. Hygienic Laboratory Bulletin 65, 1910.

form is possible; without it practically nothing is possible. Undue sentiment for the dog should not be allowed to blind us to his dangerous possibilities as a carrier of diseases and parasites or to stand in the way of effective measures for the protection of human life and health. The time seems to be at hand when the stray dog, the sheep-killing cur, the vagrant carrier of dangerous parasites and of the horrors of rabies should be exterminated. The destruction of such dogs would mean a saving of hundreds of lives and the saving and making of millions of dollars.

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